

## **Injury Criteria for Enhanced Passive Safety in Aircraft (ICEPS)**

### **(Summary)**

In aircraft as well as automotive technology, the HIC (Head Injury Criterion) is being used as an assessment criterion for head injuries in accidents.

As pass-fail criterion, however, the HIC is disputed and is discussed controversially. Strictly speaking, the HIC is applicable only for head impacts on rigid structural components in a forward motion.

As sole assessment criterion for passive safety in aircraft, the HIC is definitely insufficient. In addition, there are currently the maximum-limited thigh forces, maximum shoulder belt forces - if existing - and, in particular for the downward test, the force in the vertebral column. The existing Joint Airworthiness Requirements (JAR) for transport aircraft are outlined in section JAR 25.562.

In automotive technology, there are far more assessment criteria such as chest impression; chest acceleration; pelvic acceleration; etc. Furthermore, there are a number of requirements (FMVSS; ECE) to assess the interior of a passenger car.

In a first step, passenger injuries were determined for two aircraft accidents, Kegworth and Warsaw, and the loads effective in the aircraft cabin were derived. For the assessment of the severity of injuries, the generally acknowledged Abbreviated Injury Score (AIS) was applied. The AIS values allow a clear representation of the passengers' severity of injuries for each body region. It was possible to derive fundamental statements about the passengers' motion course during the crash and the resulting visually perceivable injuries as well as fractures and interior injuries.

Overviews of relevant criteria for the enhancement of passive safety in aircraft were set up, based on an analysis of the protection criteria for dummies used in the automotive industry, by which the safety of passenger cars is assessed with simulated car accidents. Furthermore, criteria for the assessment of the passenger car interior were analysed and applied at the example of the two aircraft types A310 and B737.

The evaluation of criteria for the enhancement of passive safety in aircraft cabins is aimed at the general prerequisite that passengers must rescue themselves at first after a crash. Immediately after a crash, there is normally no direct help available trying to evacuate the passengers from outside. The passengers must be able to free themselves and leave the aircraft on their own. This requirement includes those criteria which evaluate

?? the passengers' state of consciousness,

?? the passengers' ability to free themselves and

?? the passengers' ability to walk.

The criteria were compared with the determined passenger injuries of the two examined aircraft accidents. Injuries by which the passengers' autonomous

evacuation is endangered, for which, however, no adequate criteria are applied so far, e. g. injuries of the arms or legs, are outlined separately.

A biomechanic consideration compiles human tolerance currently dealt with in literature. The protection criteria derived from the tolerance limits and the limits currently discussed are represented for each body region.

Based on the accident analyses and criteria applied in automobile and aircraft industry, and on human tolerance defined in literature, criteria were derived for an enhancement of passive safety in aircraft cabins.

The research project was presented to and discussed with representatives of the aviation authorities of Austria and Germany.